Space Weather Technical Forecast

Issued on Sunday, 28 July 2024 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2/Minor to Moderate Storms expected into Day 2 and Day 3 (29-30 Jul) with a chance on Day 4 (31 July) given potential CME arrivals. Isolated R1-R2 Radio Blackouts expected throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with several M-class flare, the largest of which was an M9.9 peaking at 28/0158 UTC from the cluster of regions located in the southeast, likely near AR3766. A further M7.7 flare was observed peaking at 28/1042 UTC.
There are currently up to nine sunspot regions on the solar disc. AR3762, in the southwest quadrant, remains the largest and most complex region. Its trailing portion has weakened and decreased in size reducing the longitudinal length of the region, as a result it is now analysed as an Eai/ BGD. It continues to exhibit a delta configuration. The cluster of sunspot regions transiting across the southeast quadrant continues to grow in size and complexity, with intricate magnetic looping bringing additional instability. AR3768, in the southwest quadrant, grew significantly, with the appearance of a couple of spots with penumbra. The as yet unnumbered region in the northeast is continuing to develop. All other remaining regions appear small, simple and/or largely unchanged.
Associated with the M9.9 was a CME, which likely coincided with possibly as many as two other CMEs around the same time. This has made analysis very challenging, early results suggest it is slow moving, but may have an Earth-directed component with an arrival during the second half of the 31st July UTC day (day 4). Further analysis will be required for a more confident forecast.
A partial halo CME was observed shortly after 27/0600 UTC. It may be attributed to AR3762 since dimming was observed at a similar time but the signal is contaminated by the large far-sided event, resulting in a low confidence analysis with an arrival at Earth possible at the end of 29 July or beginning of 30 July UTC days (days 2 and 3).

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, have steadily declined through the period, from 450 km/s to below 400 km/s. Density was well below average. The Interplanetary magnetic field, Bt, was weak falling to below 5nT. The north-south component, Bz, was weak and largely positive. The phi angle was predominately positive (away from the Sun). Resulting geomagnetic activity was generally Quiet to Unsettled (Kp 1-3), with an Active (Kp4) interval observed between 27/1200-1500 UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 is at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was mostly at background levels. The 24-hour fluence was well below Active with 3.43e6 integrated pfu observed at 28/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to be Moderate with further M-class flares expected and slight chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: Current solar wind speeds are thought likely to continue at background levels in the absence of CME influence over the next 24 hours, perhaps down to slow-ambient levels. Geomagnetic activity is therefore expected to be generally Quiet to Unsettled at first but to increase to G1-G2 Minor to Moderate storm conditions at the end of Day 2 and into Day 3 (29-30 July), with a slight chance of G3 Strong Storm given the potential for the aforementioned CME arrival. The low confidence arrival of a further CME on the 31st July may result in further enhanced geomagnetic activity on day 4.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels. However, there is a slight chance of exceeding the S1/Minor Storm threshold should any notable flares occur, most likely from AR3762 in the near term.
The high energy electron flux is most likely to stay at background levels but may show an increasing trend on Day 3 and Day 4. The associated 24-hour fluence is most likely to remain below the Active threshold (1e8 integrated pfu) but with a potential rising trend during the period.

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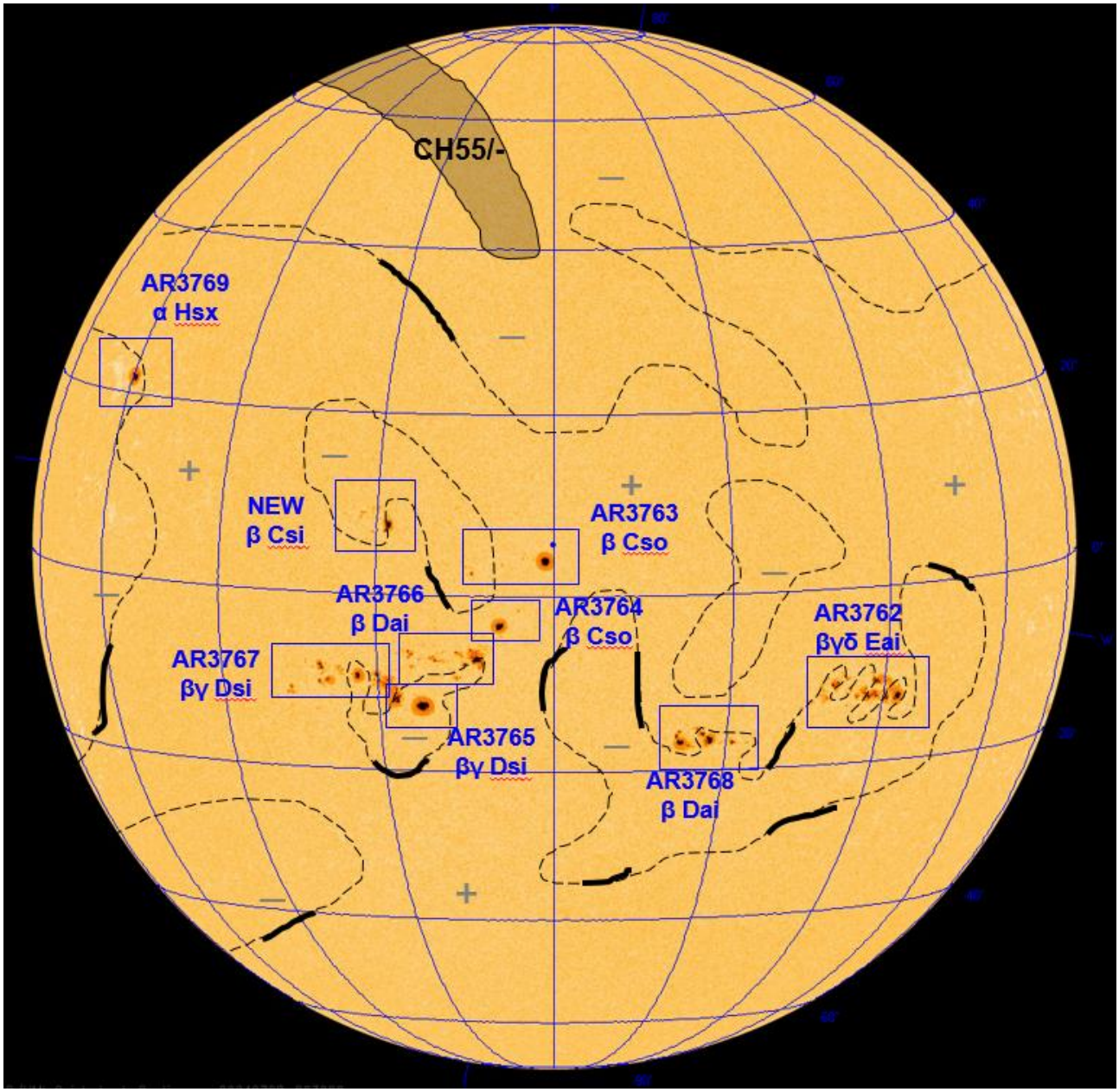
Figure 1. Solar Analysis Valid *.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Coronal hole HSS feature in this forecast. A filament lift-off and associated CME from the southern centre disk were observed in coronagraph imagery late on the 26th. This feature was analysed as Earth directed, with an arrival into Day 3 (30 Jul). However, the CME that was observed leaving the sun shortly after 27/0600 UTC has been analysed as potentially Earth-directed too. This CME is estimated to travel at a faster velocity and to catch up the first one before it reaches Earth, sometime at the end of Day 2 or beginning of Day 3 (29/30 July). Confidence is however low.

Current solar wind speeds are thought likely to continue at background levels in the absence of CME influence over the next 24 hours. Geomagnetic activity is therefore expected to be generally Quiet to Unsettled at first but to increase to G1-G2 Minor to Moderate storm conditions at the end of Day 2 and into Day 3 (29/30 July), with a slight chance of G3 Strong Storm given the potential for the aforementioned CME arrival. The low confidence arrival of a further CME on Day 4 (31st July) means the chance of enhanced geomagnetic activity also includes this day.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	60	60	40
Strong	G3	No	1	20	15	1
Severe	G4	No	1	5	5	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/1100	Full	M3.1 flare	AR3762	740km/s	29/2100UTC +/_ 6 hrs	Low confidence

Figure 2: MOSWOC Enlil shows CME arrival approx. 29/2100UTC

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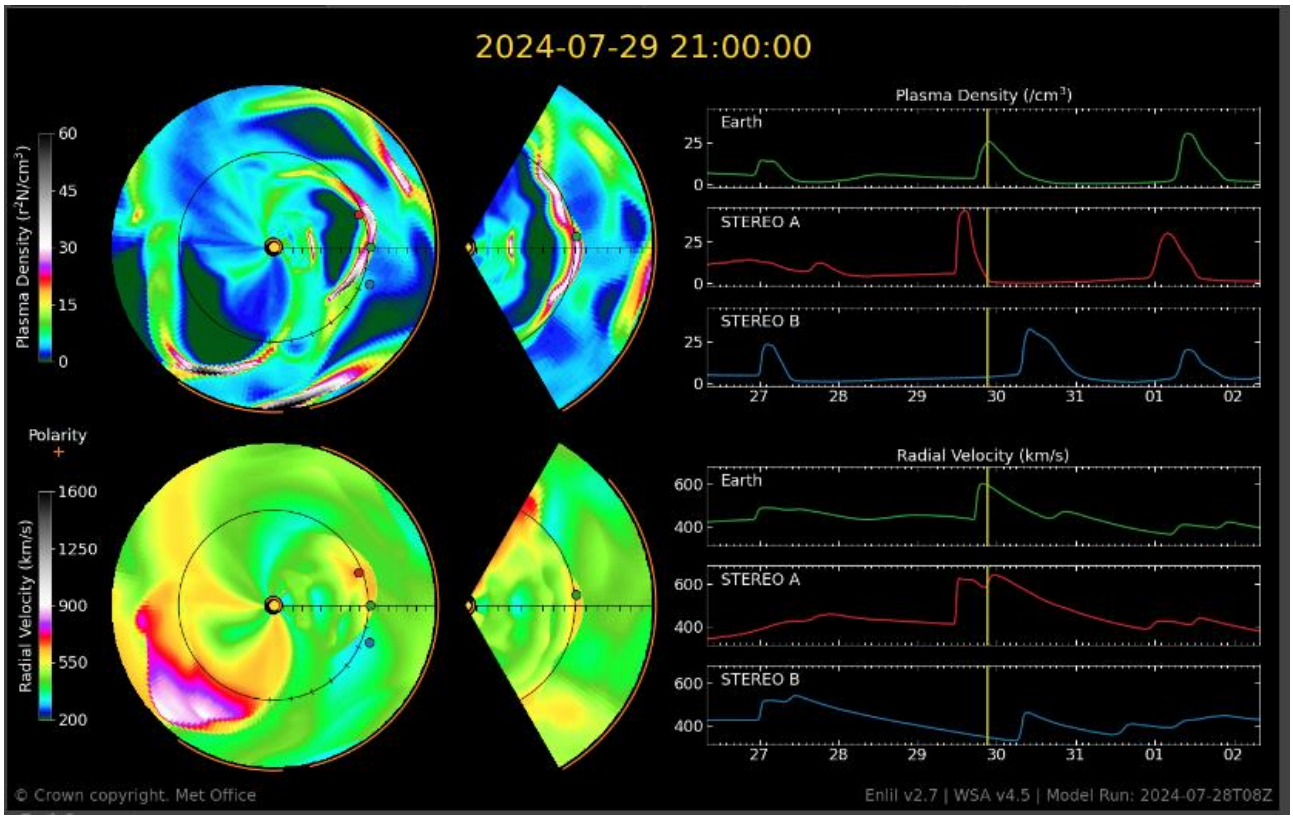

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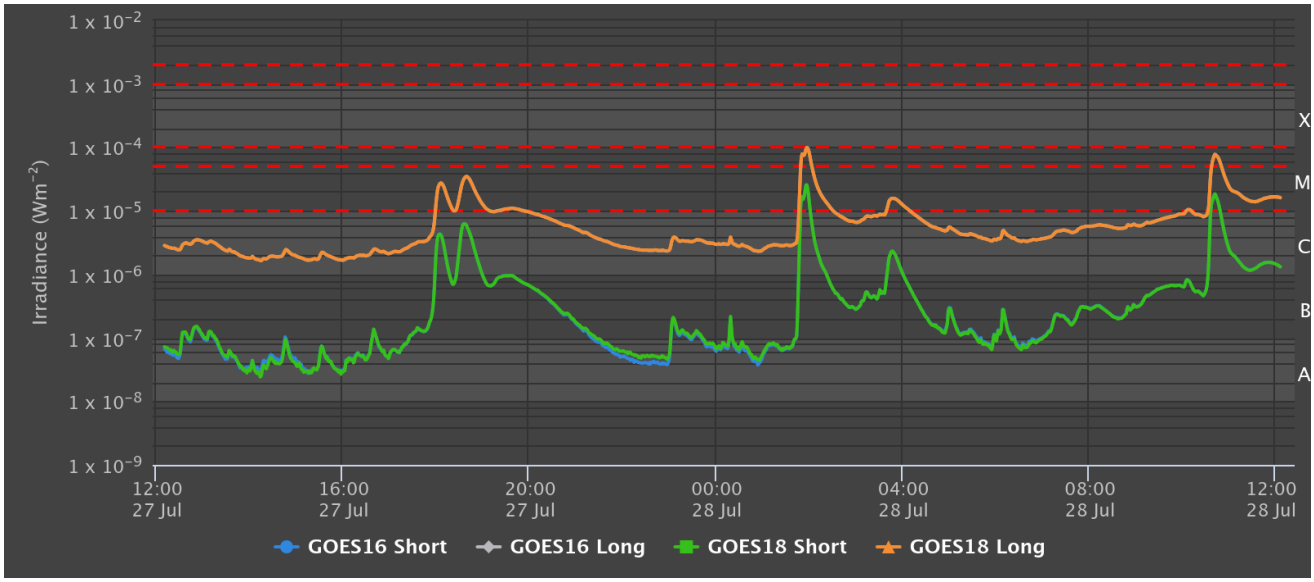
Radio Blackouts - X-Ray Flares:
There are currently up to ten sunspot regions on the solar disc. AR3762, in the southwest quadrant, remains the largest and most complex region. Its leading portion is showing signs of growth with an agglomeration of spots around a large penumbra but its trailing portion is becoming faint although it continues to exhibit a delta spot. The cluster of sunspot regions transiting across the southeast quadrant continues to grow in size and complexity, with intricate magnetic looping bringing additional instability. All other remaining regions appear small, simple and/or largely unchanged.

Overall activity is expected to be Low to Moderate with further M-class flares likely and slight chance of isolated X-class flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	80	80	80	80
Very Active	**R3 to R5 X Class**	No	15	15	15	15

Figure 3: GOES18 X-Ray flux



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Solar Radiation Storms - (High Energy Protons):
High energy protons are currently at background levels. Proton flux is most likely to remain at background levels, although there is a slight chance of reaching the S1/minor radiation storm threshold, should any notable flare occur. The best candidate is currently AR3762 given its location on the visible disc, the risk considered to increase slightly on Day 3 and Day 4 (30-31 July) when the cluster of active regions is expected to arrive into the southwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16, is expected to remain at background levels for the start of the period. The recent CME and potential fast wind enhancement may have caused an increase in electron flux below GEO, but the potential for further CME arrivals into the period could suppress this once again. Overall, electron flux is most likely to stay at background levels, but as the solar wind speeds decline there is the possibility of an increase to peak at moderate or perhaps high levels at times.
The associated electron fluence is most likely to persist below the Active threshold (1e8 integrated pfu), but with the potential for a rising trend during the period. The latest MOSWOC REFM output is forecasting a rising trend below Active, which is viewed as generally good guidance though with lower than usual confidence given the potential for further CME influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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